CS BITS & BYTES
National Science Foundation

In celebration of CS Education Week 2011, NSF is rolling out CS Bits & Bytes, a one-page biweekly newsletter for the classroom highlighting innovative computer science research; sign up at: www.nsf.gov/cise/csbytes/.

December 19, 2011
Volume 1, Issue 2

Building a Better Battery

What if you could charge your phone in minutes and it would run for days on that single charge? What if you could fully charge an electric car in a half hour and it would run for hundreds of miles? Commercial batteries like these don't exist now, but that may change soon. Materials scientists are harnessing the power of computing to custom design new batteries that are lightweight, store lots of energy, and charge quickly.

Current batteries are limited by the materials used to make them. Ideal materials would be able to store a lot of energy without weighing a lot and would be able to deliver that energy quickly (think 0 – 60 in under 7 seconds). How quickly you can charge and use a battery depends on the type of materials it's made from: charge some materials too fast, and they could catch fire or even blow up.

TRY THIS AT HOME!

Courtesy of Adam Kemp
http://www.monkeysee.com/play/6354-how-to-make-a-potato-battery

There are lots of possible materials to use in making batteries. You can even make a battery out of **lemons or potatoes!**

With so many materials you can use for batteries and so many possible combinations of those materials, **how are scientists working to find a better battery?** The Materials Project at MIT has screened 80,000 combinations of materials for batteries, solar cells, and computer chips virtually, using high performance computers. The computers solve physics equations to calculate the properties of the materials and investigate how tweaking the amounts of each of the components will impact those properties. With massive computing power, time and money are saved!

High Performance Computers (HPC), also called supercomputers, use thousands of microprocessor chips to run billions of calculations quickly in order to solve a problem. The Materials Project uses a supercomputer called **Hopper** to run these computations. It's massive - Hopper has 153,216 computer cores, 217 Terabytes of memory, and 2 Petabytes of online storage. Most of today's personal computers have either 2 or 4 cores, with .01 Terabytes of memory. Computations that can be completed in hours on a supercomputer might take decades on the fastest personal computer.

Find out more about the supercomputer, Hopper at: https://www.nersc.gov/users/computational-systems/hopper/.

Drs. Persson and Ceder with Coqueline Courreges and the Zooop 1 car.

Who thinks of this stuff? Dr. Kristin Persson and Dr. Gerbrand Ceder are the founders of the Materials Project. Dr. Persson is a research chemist at the Lawrence Berkeley National Laboratory in California and Dr. Gerbrand Ceder is a materials science and engineering professor at MIT in Boston, MA. Their work on the Materials Project has taken them to Paris, France to test drive the Zooop 1, a space age electric car. The car designers, Andre and Coqueline Courreges, invited the team to advise them on designing better batteries for their artistic high performance electric vehicles.

The Materials Project has support from the National Science Foundation and the U.S. Department of Energy. See the Materials Project website to learn more and design your own battery: http://www.materialsproject.org.

Links:

In the future, perhaps we won't be making batteries, but instead growing them! See the future: http://www.ted.com/talks/angela_belcher_using_nature_to_grow_batteries.html.

Cooked potato batteries are being proposed as a cheap, efficient way to light up parts of the developing world. Read about this at: http://www.cleanbreak.ca/2010/06/28/boiled-potatoes-solar-bulbs-can-bring-affordable-light-to-developing-world/.

Learn more about the importance of studying simulations at: http://www.ist.ucf.edu/background.htm.

Activities:

To introduce the idea of how scientists use computational simulations to explore material properties, students can download and run a simple simulation showing how the mass, volume, and density of an object determine whether or not it will float in water. Ask your students to hypothesize what may happen when they alter the properties of the object, run the simulation, and observe the results. The simulation can be downloaded from the University of Colorado at: http://phet.colorado.edu/en/simulation/density.

Other simulations that reflect simple laws of physics can be tried at: http://www.design-simulation.com/ip/simulationlibrary/flashsimulations/WeightMassAndGravity01.swf.

Class Discussion: Ask students: Why is the supercomputer mentioned above called Hopper?

Grace Murray Hopper is a pioneer in computer science. She is credited with developing the first compiler, with ideas leading to the COBOL programming language, and with being the first to use the term "bug" with respect to computers when she removed a moth from her computer. She is an inspiration to the computing community. There is even a conference in her honor that brings together nearly 3,000 participants, the Grace Hopper Celebration of Women in Computing. CS Education Week also celebrates Grace Hopper, as it occurs each year during the week of her birthday (December 9). To learn more about Grace Hopper, go to: http://gracehopper.org/2011/about/about-grace-hopper/.

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